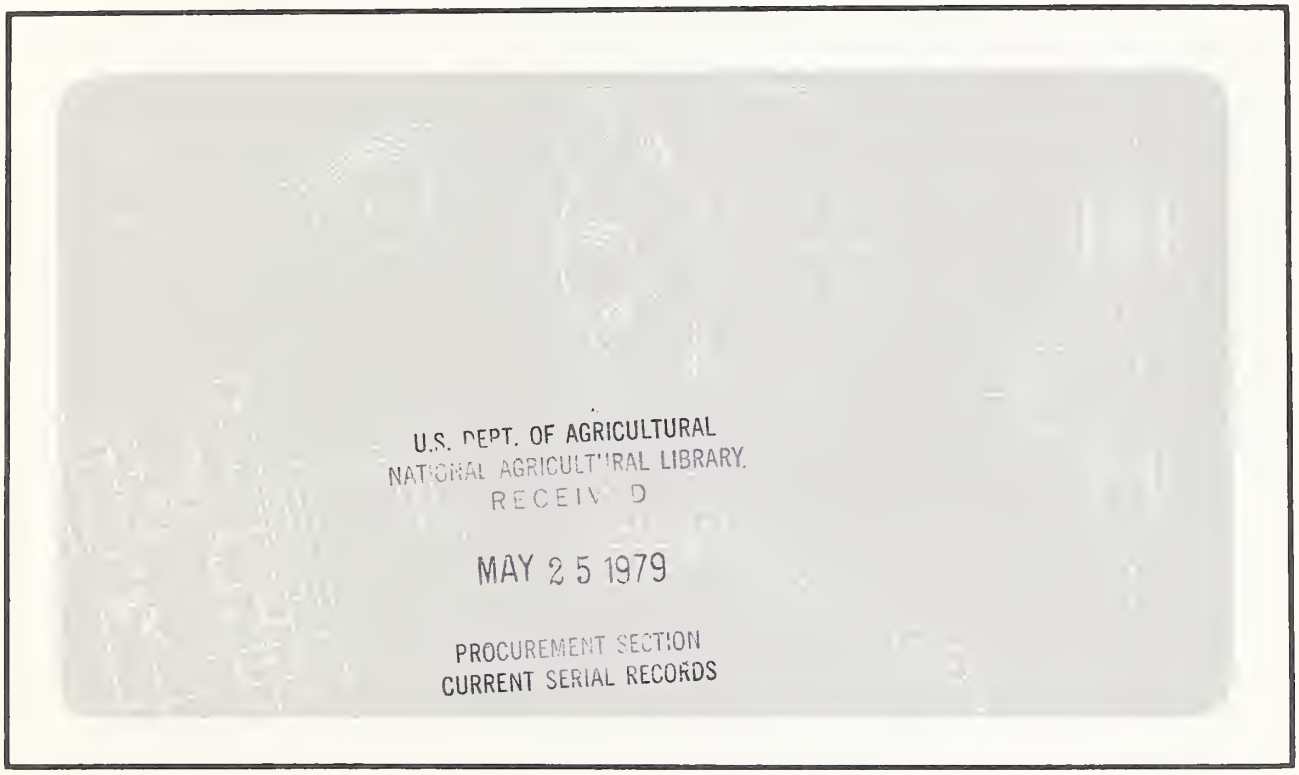
Actuator System for Operating Small Ball Valves



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H. A. Stephens and W. C. Jordan, engineering technicians, Boll Weevil Research Laboratory, assisted in the development of this system.

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ILLUSTRATIONS

Actuator System for Operating Small Ball Valves

By J. G. Griffin[1]

ABSTRACT

The system consists of two-way ball valves; a liquid manifold; an air-valve manifold with four-way, electrically operated air valves; double-acting air cylinders; and a recycling timer-switch unit. The parts are mounted on a metal frame. The system was developed for use in the manufacture of food pellets for boll weevils but could be adapted to operations requiring one or more flow-control valves to be operated in sequence or all at once. Index terms: actuators (small-valve), *Anthonomus grandis* Boheman, controllers (pneumatic), insect-diet handling, insect-rearing equipment, materials-handling equipment.

INTRODUCTION

Mechanical equipment is used to make food pellets for boll weevils, *Anthonomus grandis* Boheman, at the Robert T. Gast Rearing Laboratory, Mississippi State, Miss. (Griffin and Lindig 1974). The pellet machine has 12 forming tubes, and each tube has a valve to control the flow time and sequence of the diet mixture into the tubes. A valve to one tube is opened, allowing the diet flowing from the sterilizer to enter and approximately fill the tube. Then a second valve is opened, and the first valve is closed. This procedure continues until all valves have been opened one at a time and all tubes filled with diet. While the tubes are being filled, the diet in the first tube cools, causing it to congeal. After the last tube has been filled, the valve to the first tube is again opened, allowing more diet to enter. This flow of fresh, warm diet forces the congealed material out the tube. Again, the other forming tubes are filled and emptied in proper sequence. This procedure is repeated continuously during the pellet-making operation, and correct flow time and sequence are essential for satisfactory operation of the machine. But operating these valves manually and correctly is a boring task, and so we developed an automatic valve-actuator system. This system could be adapted for similar operations requiring one or more flow-control valves to be operated in sequence or all at once.

EQUIPMENT

The system consists of 12 two-way ball valves; a diet (liquid) manifold with 12 discharge outlets and 1 inlet; an air-valve manifold with 12 four-way, electrically operated air valves; 12 double-acting air cylinders; and a 12-cam, recycling, timer-switch unit. The parts are mounted on a metal frame (fig. 1).

The ball valves are Dyna-quip model V4TF2A, ¼-inch size, with 4-inch-long flat handles in a lazy-Z shape. The handles are turned 90° to open or close the valves. A ¼-inch hole is drilled through the flat dimension of each handle 2½ inches from the center of the ball stem of the valve and ⅜ inch from the edge of the handle nearest the air cylinder; the holes are for connecting the rod end of the air cylinders. The valves are mounted on the frame angle with brackets and bolts and are spaced along the angle to aline with the nipples on the diet manifold.

The main part of the diet manifold, constructed of ½-inch stainless-steel pipe, is 51 inches long. There is a removable pipe cap on each end of the pipe for convenient flushing and cleaning. A hole is drilled and threaded with ¼-inch-pipe threads in one of the

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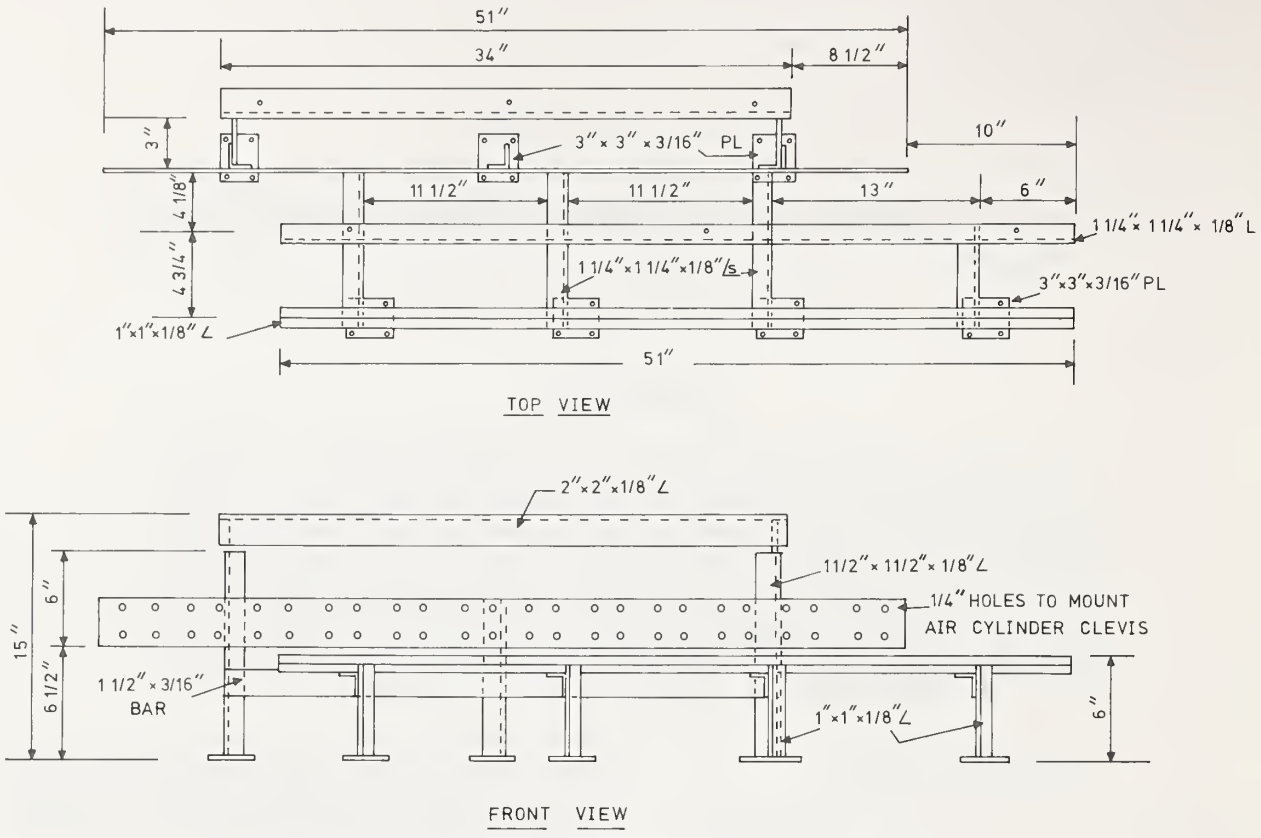

FIGURE 1.—Mounting frame for automatic valve-actuator system.

caps for attaching the incoming diet-transfer hose. Twelve outlets (⅜-inch outside diameter; 0.035-inch wall thickness; 4-inch-long nipples) are installed 4⅛ inches on center along the central part of the manifold pipe. The nipples are welded to the pipe, and the other ends are connected to the ball valves with compression-type tube fittings. The manifold is anchored to its mounting angle on the frame with three stainless-steel hose clamps.

The air-valve manifold, a Humphrey's model TM 12, has the capacity to handle 12 air valves. The air valves—four-way, electrically operated—are Humphrey's Tyna-Myte series, model T125–4EI. The manifold provides a common air source and air exhaust to all the valves. An air-pressure regulator and gage are installed in the air-supply line feeding the manifold. The regulator is set to provide 20 pounds per square inch of air pressure to the valves.

The air cylinders have a 1-inch bore and a 3½-inch stroke. They are positioned between the mounting bar and valve handles so that they are horizontal and form a 45° angle between the lines of the cylinders and the valve handles when the valves are fully open or closed (figs. 2–4). Each cylinder is connected to a ball-valve handle with the rod end clevis and the mounting bar on the frame with the base end clevis brackets. Regular ¼-inch plastic airhose connects the cylinder with the air valve.

The multiple-cam timer-switch unit is an Industrial Timer Corp. model MC 12, with a cycle time of 40 seconds. The unit consists of a motor with a drive shaft, 12 adjustable cams mounted on and connected to the drive shaft, and 12 switches. Each of the switches is actuated by one of the cams. The cams are adjustable to give a range of 2 to 98 percent of the cycle time as an "on" or "off" position of the switch. The cams for our operation are set to give a switch-closed time of 3¾ seconds and an open time of 36¼ seconds. These time periods allow about a ½-second overlap for the "on" time between any two adjacent switches. Some time overlap is necessary because the diet mixture is moved through the system by a high-pressure positive-displacement pump, and this overlap assures that there is a valve open and therefore an outlet for the diet to flow through at all times. The timer unit is located in a box mounted to the main frame by bolts (figs. 2 and 3).

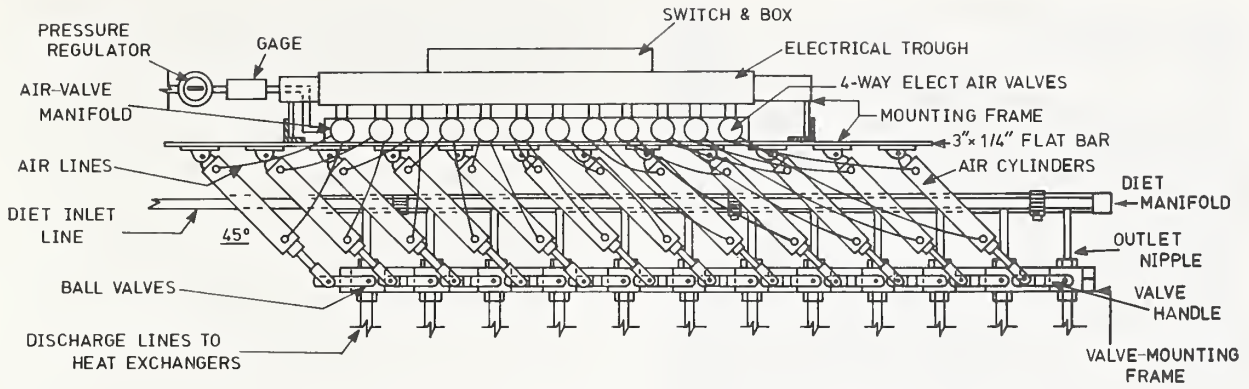

FIGURE 2.—Schematic top view of actuator system.

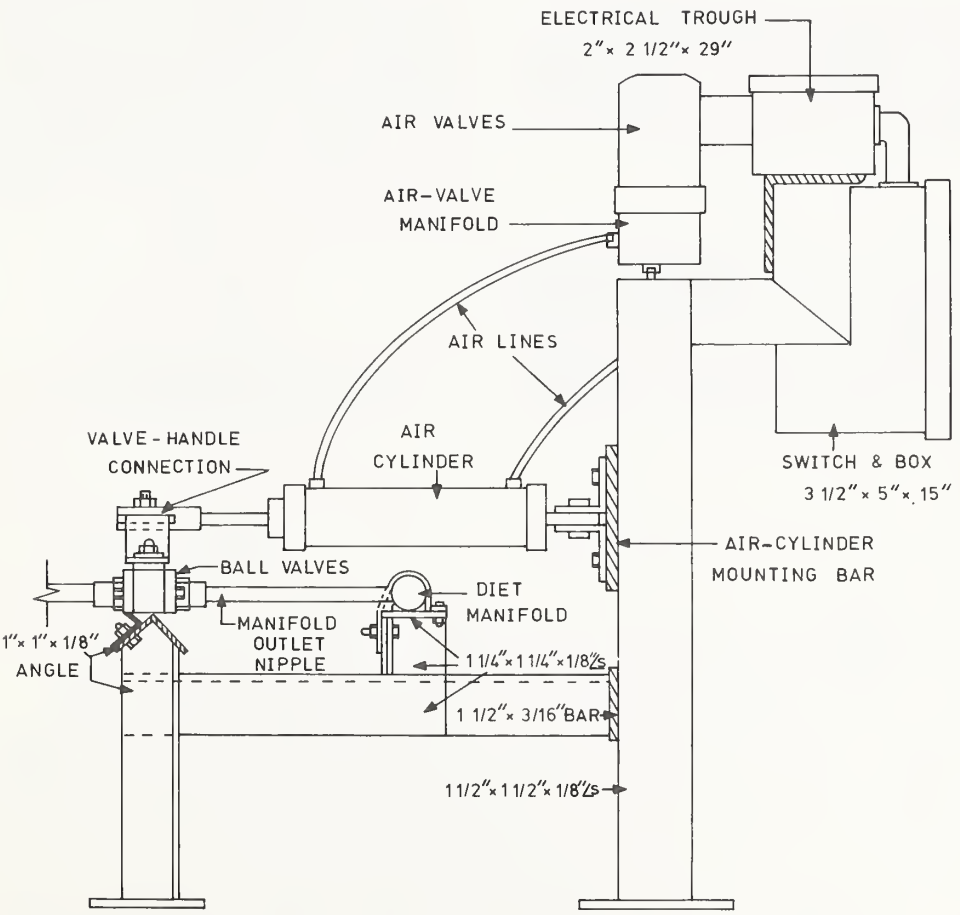

FIGURE 3.—Schematic end view of actuator system.

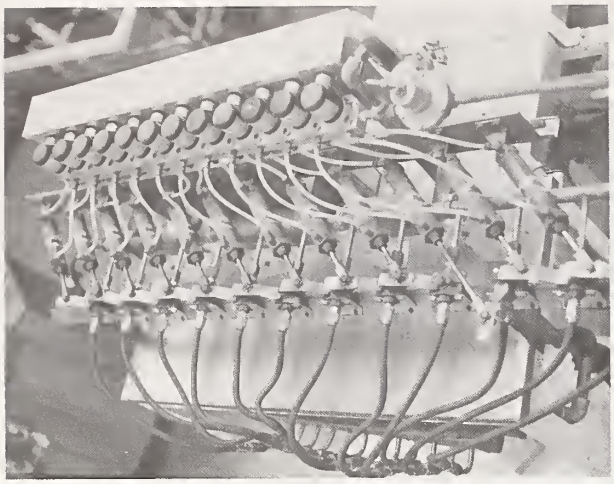

FIGURE 4.—Pictorial view of actuator system.

The coils of the air valves are connected to the electrical source circuit through the switches of the timer (fig. 5). A trough or box is used to make the connections of the wires from the valve coils and the switches and is mounted on the frame.

OPERATION

When the electrical circuit-control switch (fig. 5) is closed, the timer motor is energized and starts rotating the shaft and cams. Also, current flows through the closed switch of the timer and energizes the air-valve coil, which is served by the closed switch. This air valve allows air to flow in and out of the cylinder it serves, causing the cylinder rod to move the attached valve handle in a direction to open the ball valve. The diet flows from the manifold through the open valve into the forming tube. As the motor continues to rotate the cam shaft, the next cam in the sequence closes its respective switch, allowing the next air valve and cylinder to operate and thereby open the next ball valve. About one-half second after the second cam closes its switch, the first cam opens the first switch, causing the first air valve to operate the air cylinder and close the ball valve opened first. This stops the flow of diet through the first valve and requires it to flow through the second valve. This sequence continues until all 12 ball valves have been operated, and it is continuously repeated until the pellet-making operation is completed. Thus, the actuator system provides a satisfactory control for the diet flow pattern, time, and sequence into each of the discharge tubes to the heat-exchanger unit. It also saves the time and labor of a full-time operator while the machine is operating. If the cams are accurately adjusted and set, a uniform flow time is assured for each tube, and it is not possible for all control valves to be closed at the same time, as they might be if they were manually operated.

REFERENCE

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1974. Mechanized production of boll weevil diet pellets. Trans. ASAE 17(1): 15–16, 19.

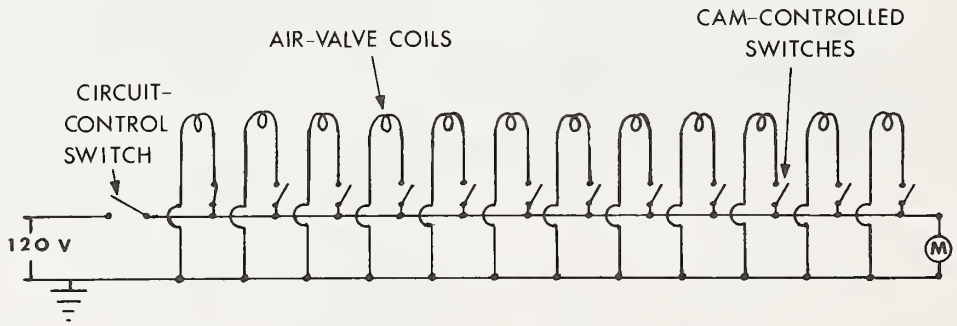

FIGURE 5.—Wiring diagram for actuator system.

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